National Aeronautics and Space Administration

Bioculture System

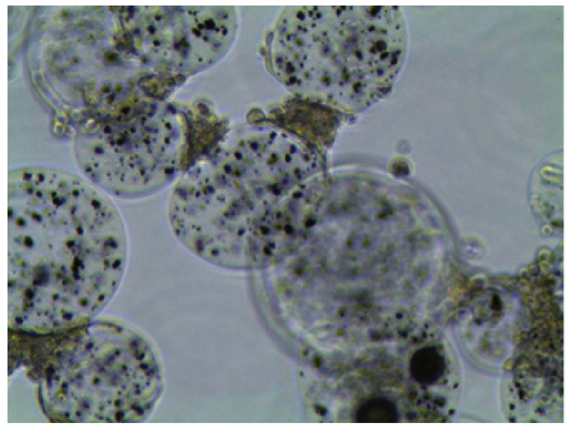
Advancing cell, tissue, and microbiology spaceflight research aboard the International Space Station

The Bioculture System is a cell biology research platform for the International Space Station that supports short- and long-duration studies involving the culture of living cells, microbes, and tissues in the unique microgravity environment of spaceflight.

Microgravity affects most organ systems of the body. Research conducted in space is essential for us to understand the biological consequences of these effects and to develop countermeasures—procedures, drugs or devices—to protect health. Gaining a deeper understanding of the mechanistic role of gravity in the regulation of biological systems is a high priority research goal for NASA. The Bioculture System supports this goal by broadening the scope of microgravity experiments available to scientists.

Bioculture System shown with one of the Cassettes removed. (Image credit: NASA / Dominic Hart)

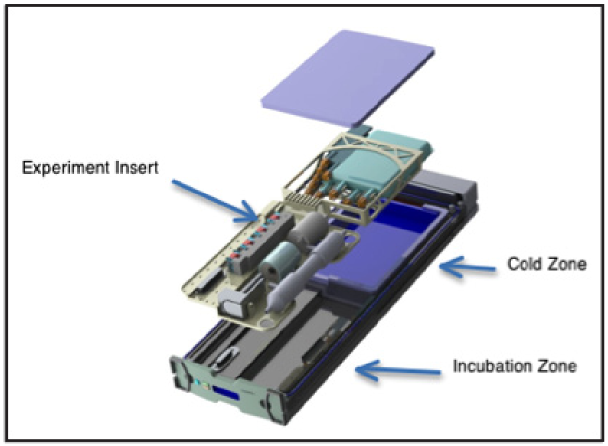
Based upon the prior generation Cell Culture Module that flew on 21 space shuttle missions, the new system houses ten independent Cassettes, each of which may run for months aboard the station—far longer than the previous shuttle mission limit of two weeks.



Human cardiomyocytes cultured onto Global Eukaryotic Microcarrier beads. Similar cultures will be flown in the validation mission (Image Credit: NASA, Natalya Dvorochkin)

Academic and commercial researchers may use the Bioculture System to study a wide range of biological processes in microgravity that are relevant to human health. These experiments can help us understand how gravity affects the physiology, biochemistry, genetics and gene expression of living cells, tissues and microbes. For example, cells and tissues cultured during spaceflight may be characterized using various "omics" techniques, used for drug discovery and countermeasure analyses, or used to study infectious disease processes. Other possible applications, which are not limited to these examples, include spaceflight studies of tissue engineering, regeneration, and wound healing.

Each Cassette contains a fluidics flow path and biochamber for perfusion-based culturing and is divided into two independent temperature zones; an incubation zone for the biochamber, and an insulated cold zone for culture medium or other temperature-sensitive solutions and collected specimens. Temperature control is independent for each cassette and the gas supply is shared. A power and command module supplies power and data ports to each Cassette.



Exploded view of an incubator Cassette. (Image credit: Tissue Genesis, Inc.)

Automated functions include 1) user-selected set point pre-programming of temperature settings, fluid flow rate, fluid circulation duration, fluid delivery modes, samplings volume and timeline, and injections volume and timeline and 2) gas supply delivery.

The system supports real-time experiment environment monitoring, hardware commanding, and manual crew operations—including change out of biochambers and fluid bags, sampling, and injections. Cultures may be initiated aboard the station from frozen or liquid stocks. Subculture is supported.

The system provides containment for biospecimens up to Biological Safety Level 2, and chemicals up to toxicological hazard level 2. The Cassettes will fit into the International Space Station Microgravity Sciences Glovebox for manual operations that require continuous containment or a sterile field.

The first Bioculture System is scheduled to fly to the station aboard SpaceX-9 in 2015. Station crew will install the system in the U.S. Destiny module. Once installed, the system will be monitored and commanded by ground staff at NASA's Ames Research Center in Moffett Field, Calif.

The goals for the first flight are to validate system performance and demonstrate manual crew operations. The study will involve the culture of cardiomyocytes and adipose tissue-derived stem cells for a period of up to 30 days. The system will be available for use by researchers after the validation study is completed.

The Bioculture System is being developed at Ames under the leadership of the Ames Research Center International Space Station Utilization Office and within the Space Biosciences Division.

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For more information, contact:
Edward Austin
Project Manager
NASA Ames Research Center
edward.m.austin@nasa.gov
www.nasa.gov/ames/research/space-biosciences

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, CA 94035

www.nasa.gov

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